Generation X Study

Propulsion

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Propulsion Topics

- **Driving Requirements and Assumptions**
- **Propulsion Options**
  - Solid Motor
  - Electric
- **Comparison**
- **Additional Trades to Consider**
- **Risk Assessment**
- **Issues and Concerns**

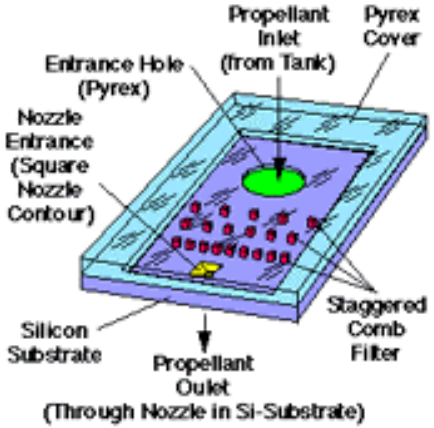
Propulsion
Driving Requirements

- Provide delta V from LEO to L2
- Provide microthrust for detector boom stabilization

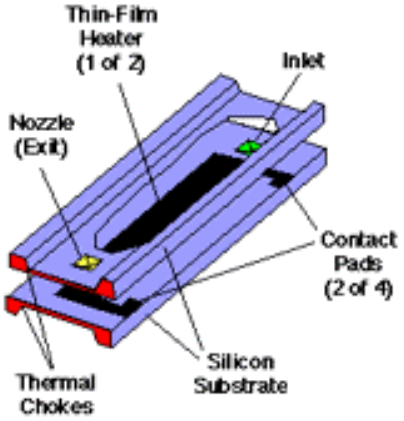
Propulsion
Boom Stabilization Options

- **Thruster on a Chip**
- **Subliming Solid/Liquid**

SUBLIMING SOLID MICRO-THRUSTER



VAPORIZING LIQUID MICRO-THRUSTER



Propulsion
Transfer Orbit Options

- **Solid Propellant Motor**
  - Larger than STAR 75
- **Electric**
  - XIPS
  - MPD
  - SPT

Propulsion
Solid Motor Option

- **Pro**
  - Proven Technology
  - High Thrust
    - maneuver performed more efficiently
- **Con**
  - Contamination
  - Low specific impulse
    - requires large propellant mass

Propulsion
Solid Motor Option

Approximately twice size of a STAR 75

Performance Goal

Propellant Mass Fraction 0.93

Isp = 290

Propellant mass ~14,000 kg

Propulsion
Electric Options

- **Pro**
  - High specific impulse >1000sec
    - Low propellant mass

- **Con**
  - Requires large amounts of power
  - Primarily used for NSSK- Low thrust Devices
    - longer time to reach operational orbit
    - Typical LEO-GEO ~180 days
  - Electromagnetic Interference
  - Large Propellant Tanks and fluid components not developed

Propulsion

Xe Ion Propulsion System (XIPS)

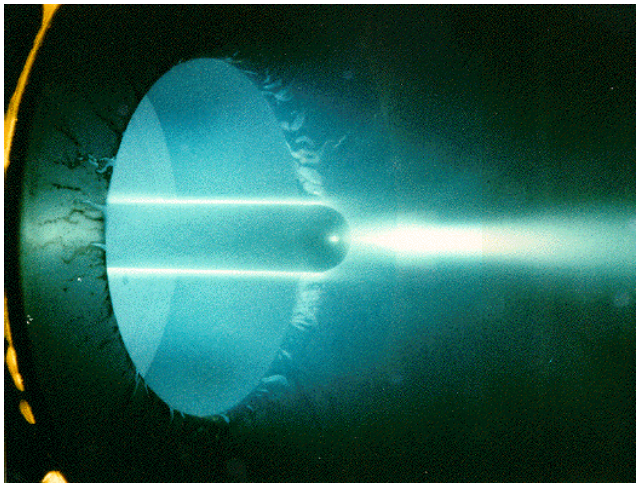
- High Specific Impulse and high power
- Significant Heritage DS-1 and HS-701
- very low thrust
- Xe propellant

- 30 centimeters
- 17.6 lbs (8 kg)
- 3100 seconds ISP
- 20 to 92 mN of thrust

Magneto Plasma Dynamic Thruster (MPD)

- High Specific Impulse and High power
- Research Models (Princeton) and Foreign Flight History (ISAS)
- Variety of Propellants

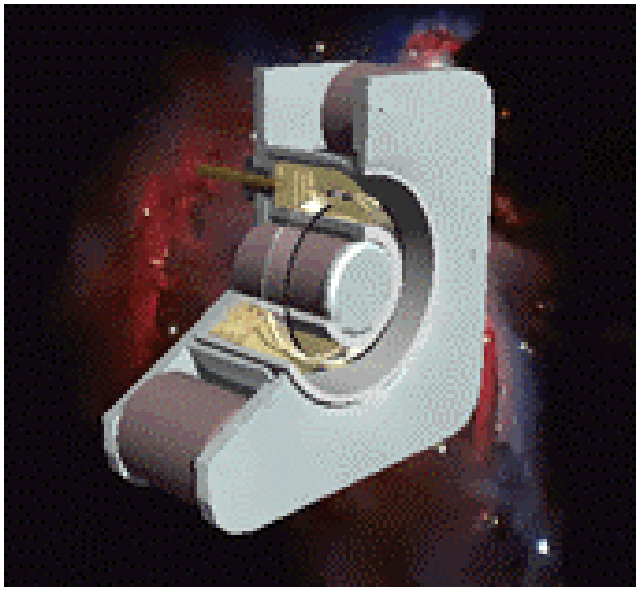
- 20 centimeters
- est. 12 kg
- 1100 seconds ISP
- 20mN to 200 N of thrust



Stationary Plasma Thruster (SPT)

- High Specific Impulse and High power
- Significant Flight History Fakel, RAIME, Loral

- 1.35 kW Engine
- 5.4 kg
- 2000 seconds ISP
- 54 mN of thrust



Propulsion Recommendation

- Solid Motor provides a solution with proven technology but is massive
- MPD thruster requires development but is very adaptable to high thrust applications

Additonal Trades

- Combination Solid Motor with Electric Propulsion
- Tankage and Thruster Location

Risk Assessment

- MPD's have flown in pulsed mode application
  - Continuous Firing not demonstrated
  - Possible life issues
- Scale-up to megawatt range being considered for Manned Mars Missions

Issues and Concerns

- Lack of Fluid Components and adequate Tankage
- Technology Development program